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The effect of LHW on tungsten transport in NBI dominant H-mode plasma in EAST

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In magnetic confinement fusion devices, high-Z material tungsten is the top candidate plasma facing materials (PFM) due to its good characteristics such as high sputtering threshold, low retention of tritium and high neutron resistance. Very recently, tungsten is planned to be used as first wall of ITER in addition to divertor plate. However, the accumulation of tungsten may significantly cool the plasma, degrade the plasma performance and even lead to the radiative collapse. It has been reported that on-axis electron cyclotron resonance heating (ECRH) and ion cyclotron resonance heating (ICRH) can be applied to suppress the tungsten accumulation in ASDEX Upgrade and JET tokamak [1, 2]. In EAST tokamak with full tungsten divertor, tungsten accumulation is often observed in NBI-dominant heating H-mode discharges. Core tungsten concentration (C_W) increase from 9×10^{-5} to 2×10^{-4} during t= 4.7-5.1 s when a low ELM frequency (f_{ELM}) of 26 Hz sustained leading to periodic H-L back transition [3]. In addition to on-axis ECRH heating [4], in EAST, the injection of low hybrid wave (LHW) at 4.6GHz is proved to be also effective for tungsten control. In a dedicated discharge, increase of electron temperature and its gradience, increase of f_{ELM}, decrease of toroidal rotation velocity and weakened up-down asymmetry distribution of tungsten ions are simultaneously observed after LHW power switched on. Density profiles of tungsten ions with different charge states, e.g., W^{27+}, W^{32+}, W^{43+} and W^{45+}, are observed by sets of high-performance space-resolved extreme ultraviolet (EUV) spectrometers [5, 6]. The experimental results suggest a tungsten decontamination effect of up to 60% by LHW injection. Modelling using TYGRO (including NEO and TGLF) and STRAHL under OMFIT framework is carried out, the results indicate that LHW can effectively control tungsten impurity accumulation by enhancing turbulent diffusion and weakening inward neoclassical convection. The experimental and simulated study in this work will contribute to the understanding of core tungsten transport and exploration of more effective experimental approaches of tungsten control both for EAST and ITER.

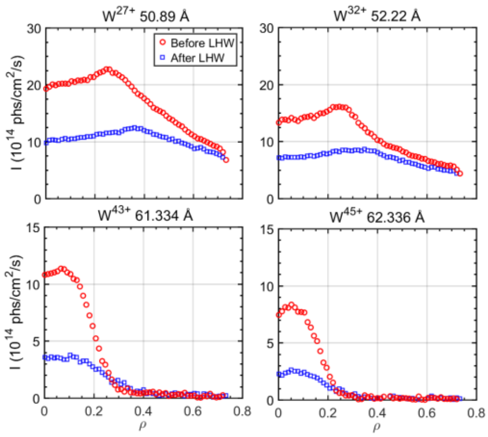

Fig. 1 Radial intensity profile of (a) W^{27+}(50.89 Å), (b) W^{32+}(52.22 Å), (c) W^{43+}(61.334 Å) and (d) W^{45+}(62.336 Å) before and after LHW injection in a NBI-dominant heating H-mode discharge.

References

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